Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction – Willamette Temperature Control, Cougar Reservoir 2002-2005

Patrick S. O’Brien, PE  CENWP-EC-HY
patrick.s.o’brien@usace.army.mil

Dr. Terry M Sobecki ERDC-EL-MS

Dr. David M. Soballe ERDC-EL-MS

Dr. John Hains ERDC-EL-MS
Sediment Management Below Reservoirs

- Wash load may be a problem when there is too much
- Cougar
- Mount St Helens Sediment Retention Structure
Need for Temperature Control

• Spring/Summer: High Pool, very cold deep water is drawn from bottom intakes of existing tower, causes downstream cold spikes reducing migration of Spring Chinook

• Fall/Winter: Low Pool, cold reservoir is used up, water becomes mixed, water warmer than pre dam, causes prespawn mortality, premature fry emergence.

• Selective withdrawal operations will restore a more natural temperature cycle.
Initial Drawdown to Construction Pool  February – June 2002

- Concrete plug to Diversion tunnel opened on February 23
- Drawdown proceeded at 3 feet/day until May 26
- Reservoir turbidity increased during drawdown, causing high turbidity downstream of the dam
- Projected turbidity averaged 30 NTU, with spikes to 100 NTU
- Actual turbidity averaged 85-100 NTU, peaks of 130 – 225 NTU, spikes ~ 1000 NTU
Downstream Effect of Drawdown
(Data from S. Frk. McK. Riv.)

Tunnel Tap
Drawdown
Fishing Season
Turbid Water in Mckenzie R, Summer 2002
Downstream Impacts of Turbidity - Public Concerns

- Severe impact to fly fishing season
- Impacts to fishery, macro invertebrates, salmonid spawning gravels
- Concerns over volume of sediment released and amount deposited downstream
- Concerns over drinking water quality
- Concerns over the possibility of DDT contamination from Cougar sediment releases
- Comments solicited from public through public meeting process
- Corps regulations for implementing NEPA provide for publishing additional supplemental information documents on long-term or complex Environmental Impact Statements (EISs) to keep the public informed.
Cougar Dam and Reservoir
Draft Supplemental Information Report

January 2003
Reservoir Operation during Construction

Construction season - October 1 to April 1

Three options available to reduce turbidity

• Increase drawdown rate (3 ft/day to 6 ft/day)
• Non-construction/winter flood control pool level – 1532 ft (high pool option) or hold pool at 1400 ft (low pool option)
• Target date to reach construction pool (high pool option) March 1 or April 1
Development of Operational Plans

6 operational scenarios were created from combinations of the 3 options

- 4 high pool (HP) options / 2 low pool (LP) options
- HEC ResSim model developed for the McKenzie River system. Period of record inflows used (1935 to 1998) to determine reservoir elevations under 6 operational scenarios.
- ResSim – elevation rate of change rule available
- Selected plan becomes part of adopted “Best Management Practices” in SIR
Reservoir model – HEC ResSim
Willamette River Temperature Control Project, Oregon

**Cougar Dam Cross-Section**

**High Pool Option**

US Army Corps of Engineers

Portland District
<table>
<thead>
<tr>
<th>Alternative</th>
<th>Target date</th>
<th>Drawdown rate</th>
<th>Winter Pool Elev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP1</td>
<td>-</td>
<td>3 ft/day</td>
<td>1400 ft</td>
</tr>
<tr>
<td>*** LP2 ***</td>
<td>-</td>
<td>6 ft/day</td>
<td>1400 ft</td>
</tr>
<tr>
<td>HP1</td>
<td>March 1</td>
<td>3 ft/day</td>
<td>1532 ft</td>
</tr>
<tr>
<td>HP2</td>
<td>April 1</td>
<td>3 ft/day</td>
<td>1532 ft</td>
</tr>
<tr>
<td>HP3</td>
<td>March 1</td>
<td>6 ft/day</td>
<td>1532 ft</td>
</tr>
<tr>
<td>HP4</td>
<td>April 1</td>
<td>6 ft/day</td>
<td>1532 ft</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>----------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td><strong>HP1</strong></td>
<td>1404</td>
<td>1405</td>
<td>1412</td>
</tr>
<tr>
<td><strong>HP2</strong></td>
<td>1454</td>
<td>1456</td>
<td>1457</td>
</tr>
<tr>
<td><strong>HP3</strong></td>
<td>1401</td>
<td>1403</td>
<td>1406</td>
</tr>
<tr>
<td><strong>HP4</strong></td>
<td>1454</td>
<td>1456</td>
<td>1459</td>
</tr>
<tr>
<td><strong>LP1</strong></td>
<td>1400</td>
<td>1401</td>
<td>1404</td>
</tr>
<tr>
<td><strong>LP2</strong></td>
<td>1396</td>
<td>1400</td>
<td>1403</td>
</tr>
</tbody>
</table>
90 % non-exceedance LP options

- 3 ft/day drawdown rate
- 6 ft/day drawdown rate
Erosional processes within Cougar

- Initial submergence of dried lakebed deposits
- Mass wasting and slope failures caused by rapidly changing pool levels
- Active erosion of predominantly clay banks
- Lateral migration and downcutting of main inflow tributaries

** cause higher levels of turbidity
Active erosion of exposed clay banks
South Fork McKenzie R. Inflow to Cougar

January 29, 2003

January 30, 2003

January 31, 2003
Rush Creek Drainage Failure

January 30, 2003

January 31, 2003

Pool maintained at 1450 feet to prevent further slope failures
USGS Monitoring Study Objectives

- Measure deposition of fine materials into spawning gravels
- Deposition of DDT in fine materials
- Compare contributions from Cougar Reservoir construction with other areas
  - 2 reference sites
    - (S. Fork above Cougar, mainstem above S. Fork)
  - 2 sites below reservoirs
    - S. Fork below Cougar, Blue River below Blue River Res.
  - Downstream integrator site
    - McKenzie R at Vida below Cougar & Blue
USGS Sediment Trap Installation and Retrieval

US Army Corps of Engineers
Portland District (J. Britton, P. O’Brien, T. Sherman)
WES (T. Sobiecki, J. Hains, D. Sobale, C. Schneider)
EWEB (K. Morgenstern)
ODFW (M. Wade)
OSU (G. Stewart, A. Jefferson)
NOAA Fisheries (L. Krasnow)

USFS (Gordon Grant)
USGS (H. Bragg, I. Wigger, E. Rupp, C. Palmer, J. O’Connor)
Infiltration Bags

- Dimensions:
  - Width: 30 cm
  - Depth: 56 cm
  - Volume: 40 L
  - Teflon liner
- Buried ~40 cm below bed
- Used experimental (non-native) rock
  - Pre-clean rocks
  - Relatively uniform porosity
  - Direct comparisons between sites
- Deployed Aug. 03 – July 04
  - 5 sites, 3 traps each
  - Spawning areas with downwelling

(Lisle and Eads, 1990)
Installation– Dig the hole!
Use a form, & backfill
Collapse bag and install
Deployed infiltration bags
Winter Storms – Regulated Sites

DISCHARGE (CFS)

TURBIDITY (FNU)

Retrieval

- July 2004
  - 3 major events during winter
  - At least one trap lost from background site
- At least 1 good bag retrieval from each site
Accumulation of Fine Materials in Spawning Gravels - Mass

- McKenzie R. Abv S. Fork (MRBO)
- Above Cougar (SFCO)
- Below Cougar (CGRO)
- Below Blue River (BLUE)
- McKenzie R. near Vida (VIDA)
Accumulation of Fine Materials in Spawning Gravels - %

PERCENT OF FINES IN TRAP (G)

Accumulation levels at different locations:
- McKenzie R. Abv S. Fork (MRBO)
- Above Cougar (SFCO)
- Below Cougar (CGRO)
- Below Blue River (BLUE)
- McKenzie R. near Vida (VIDA)
DDT CONCENTRATIONS IN DEPOSITED SEDIMENT

DDT CONCENTRATION (ug/Kg, or ppb)

- McKenzie R. (MRBO)
- Above Cougar (SFCO)
- Below Cougar (CGRO)
- Below Blue River (BLUE)
- McKenzie R. near Vida (VIDA)

Total DDT
Detection Limit
Conclusions– Sediment

- Sites below Cougar and Blue River dams had the highest deposition of fine sediment in redds
  - Slightly elevated % clays in fine material
  - Confirms previous study results
  - Contrary to much of the literature indicating coarsening of bed below dams
  - Bed moving events during the winter may allow scouring of fine material from the bed at unregulated sites
Conclusions– DDT

- DDT detected at low levels below Cougar but nowhere else
  - Probably transported downstream also but diluted by upstream sediment sources
  - Analytical issues may have obscured other DDT detections
- Concentration detected in sediment traps is about the same as detected in suspended sediment during storms, and in bank sediment (COE sampling)
- Reservoir may have acted as a sink prior to drawdown but a source during drawdown
SSC-T Relationships

- Turbidity (T) is a good surrogate for Suspended Sediment Concentration (SSC)
- SSC-Turbidity relationships for Santiam were used to estimate sediment discharge from Cougar in SIR
- Relationships are site specific – lots of factors, clays, silts, sands have a different turbidity signature.
- SCC-T relationships are developed using sediment sampling over a range of flows
- Useful sediment management tool
SSC-Turbidity Relations

Unregulated Sites (SFCO, MRBO)

Regulated Sites (CGRO, BLUE, VIDO)
Sediment Management Report Card
More Information

- Appendix C – Reservoir Operational Modeling
- Appendix D – Sediment (Estimated sediment released based on measured turbidity)
Questions